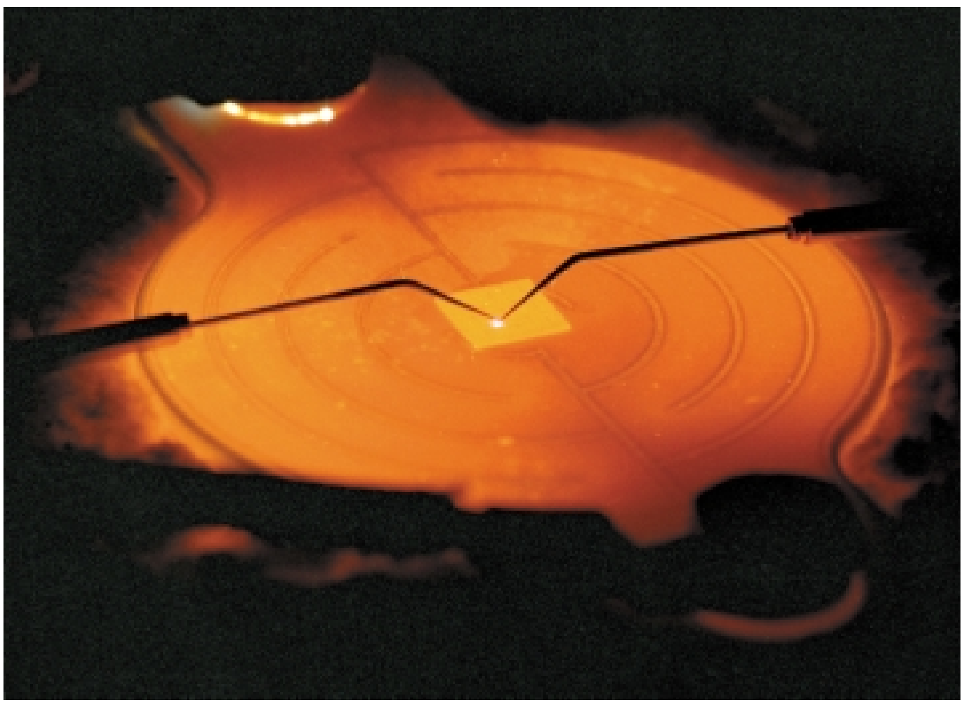
Technology Opportunity

Silicon Carbide Electronics for High-Power and High-Temperature Uses

The National Aeronautics and Space Administration (NASA) seeks to transfer technology for silicon carbide high-temperature and high-power electronics.

Potential Commercial Uses

- Aircraft—high-temperature sensors and control electronics to increase fuel efficiency while reducing emissions
- Spacecraft—increased satellite functionality at lower launch cost due to the elimination of thermal management systems
- Power—energy savings in public power distribution
- Automobiles—
  - High-power electronics for more efficient electric vehicles
  - High-temperature sensors and control electronics that reduce exhaust emissions and increase fuel efficiency
- Communications and radar—high-power microwave electronic devices for communications and radar



Blue SiC light-emitting diode (LED) operating at 600 °C. The circular heating element and the square SiC chip are both glowing red hot.

National Aeronautics and
Space Administration

Glenn Research Center

Commercial Technology Office

Benefits

- Enables electronics for environments where silicon-based electronics simply cannot function.
- Dramatically increases power density and power distribution efficiency.
- Creates a whole new industrial technology with new products and associated new-job creation.

The Technology

The NASA Glenn Research Center's High Temperature and Integrated Electronics and Sensors (HTIES) program is developing silicon carbide (SiC) as a material for advanced semiconductor electronic device applications. SiC-based electronics and sensors can operate in hostile environments (600 °F) where conventional silicon-based electronics cannot function. Silicon carbide's ability to function in high-temperature, high-power, and high-radiation conditions will enable large performance enhancements to a wide variety of systems and applications.

SiC crystal growth technology has advanced dramatically since 1993 with NASA Glenn's invention of the "site-competition epitaxial growth" process. This patented process controls the electrical character of epitaxial layers by allowing precise control over dopant incorporation during crystal growth, a crucial step toward successful development of SiC semiconductor electronics. With this process, the 1000-times purer SiC crystals can now be grown. These purer crystals are needed to realize superior high-voltage power devices in SiC, with the promise of improved efficiency and switching speed over present-day silicon power electronics. In addition, this same process allows ohmic as-deposited contacts, saving device fabrication costs by eliminating the thermal processing required for electrical contacts.

Options for Commercialization

Part of NASA's mission is to commercialize its technology, and one of NASA Glenn's aims is to commercialize new SiC technology. The commercial potential for SiC-based electronics is more than $5 billion annually in the power semiconductor device market alone. The site-competition patent rights are owned by the Ohio Aerospace Institute (OAI).

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